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(54) Abstract Title
ELECTRICAL CONTACT CLEANER

(57) A propellant-rich aerosol cleaner for use with electrical circuit boards and electrical connector components includes a solvent having a low or no ozone depletion potential and a propellant. The solvent is present in a concentration of at most about 50 percent by weight and preferably about 40 percent, and the propellant is present in a concentration of at least about 50 percent by weight and preferably about 60 percent, of the cleaner,. The cleaner exhibits a cleaning characteristic of about 0.25 milligrams of soil per gram of cleaner delivered and exhibits low to no residual flammability.

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ELECTRICAL CONTACT CLEANER

Field of the Invention

The present invention pertains to a cleaner for electrical contacts. More specifically, the present invention pertains to a propellant-rich aerosol cleaner for use on electrical circuit boards, electrical contacts and the like.

Background of the Invention

Electrical contact cleaners are used during the manufacture of electronic, telecommunications and other electrical equipment to clean the components prior to final assembly. These cleaners are also used during maintenance operations carried out on electrical equipment in order to provide for proper electrical conductivity where two conductive (e.g., metal) surfaces are to be joined to one another in electrical contact. These cleaners are used to remove grease and more particularly other contaminants such as light oils, oxidation products and the like.

Many such cleaners are provided in aerosol form. These aerosol cleaners include a solvent and a propellant. Typically, aerosol formulations are solvent-rich. That is, these cleaners include high concentrations of solvent relative to propellant. The solvent is that portion of the cleaner that dissolves or loosens the contaminants while the propellant is that portion of the cleaner that is used as a vehicle to communicate the solvent.

Early contact cleaners used a solvent of CFC-113 (Freon® TF, trichlorotrifluoroethane) as a solvent of choice. CFC-113 was an ideal candidate in that it had many advantageous characteristics, such as no flash point, no explosion limits, good solvency for hydrocarbon and fluorinated soils, and, it was believed, low toxicity. In addition, and importantly, it was found to be safe to use on plastics, such as those used for circuit board substrates. In addition, CFC-113 was found to evaporate quickly thus making it an ideal solvent. It was, however, found that CFCs, generally, and other halogenated substances could accelerate the destruction of stratospheric ozone.

As a result, numerous CFC-free contact cleaners were developed. One such cleaner was fluorodichloroethane (HCFC-141b) which became available in commercial quantities. While it was found that HCFC-141b had many of the advantageous properties of CFC

by weight of the cleaner as the solvent. An acceptable hydrofluoroether is commercially available from 3M Company of St. Paul, Minnesota under the tradename HFE 7100. In these formulations the solvent can further include isopropyl alcohol, preferably in a concentration of about 2 percent to about 4 percent by weight of the cleaner. A preferred propellant is tetrafluoroethane, preferably in a concentration of about 70 percent by weight of the cleaner, for this alternative formulation.

Other features and advantages of the present invention will be apparent from the following detailed description, in conjunction with the appended claims.

Detailed Description of the Preferred Embodiments

While the present invention is susceptible of embodiment in various forms, there will hereinafter be described presently preferred embodiments with the understanding that the present disclosure is to be considered an exemplification of the invention and is not intended to limit the invention to the specific embodiments illustrated.

An electrical contact cleaner in accordance with the present invention includes a propellant and a solvent. The cleaner is a propellant-rich formulation. That is, the cleaner includes a relatively low solvent concentration and a relatively high propellant concentration. The propellant concentration is from about 50 percent by weight of the cleaner and the solvent concentration is up to about 50 percent of the cleaner concentration on a weight basis. In one embodiment, the propellant is an HFC liquefied gas and the solvent is a brominated solvent. In a most preferred embodiment, the HFC liquefied gas is tetrafluoroethane (HFC-134a) and is present in a concentration of about 60 percent by weight and the brominated solvent is n-propyl bromide (nPB) and is present in a concentration of about 40 percent by weight. The nPB can further include a small amount of n-propanol, in which case, the nPB is about 37 percent to about 37-1/2 percent by weight and the n-propanol is about 1 percent to about 3 to 5 percent by weight of the final cleaner formulation.

It has been found that brominated solvents, and most preferably nPB, have excellent characteristics for use as an electrical contact cleaner. Specifically, these brominated solvents have been found to have good solvency and little to no flammability. In addition,

evaporation rates and is acceptably priced for the marketplace. Most desirably, such a cleaner is propellant-rich and performs as well if not better than CFC based products.

Summary of the Invention

A propellant-rich aerosol cleaner for use with electrical circuit boards and electrical connector components is formed from a solvent having a low or no ozone depletion potential and a propellant. The solvent is present in a concentration of up to about 50 percent by weight of the cleaner and the propellant is present in a concentration of from about 50 percent by weight of the cleaner. Preferably, the solvent is present in a concentration of about 20 percent to about 40 percent by weight of the cleaner, preferably about 40%, and the propellant is present in a corresponding concentration of about 60 percent to about 80 percent, by weight of the cleaner, preferably about 60%. The cleaner exhibits cleaning characteristics of about 0.25 milligrams of soil per gram of solvent delivered and exhibits no residual flammability.

In one formulation, the solvent is n-propyl bromide or other brominated solvent and can further include n-propanol. In a current formulation, the n-propyl bromide is present in a concentration of about 37 percent by weight of the cleaner and the n-propanol is present in a concentration of about 1 percent to about 5 percent by weight of the cleaner.

In this formulation, the aerosol cleaner preferably uses an HFC liquefied gas as a propellant, preferably, in a concentration of about 60 percent by weight of the cleaner. Most preferably the HFC liquefied gas is tetrafluoroethane.

In an alternative formulation, the aerosol cleaner includes trichloroethylene, preferably in a concentration of about 20 percent by weight of the cleaner as the solvent. In this formulation, the solvent can further include isopropyl alcohol, preferably in a concentration of about 2 percent to about 4 percent by weight of the cleaner. A preferred propellant is tetrafluoroethane, preferably in a concentration of about 77 percent by weight of the cleaner, for this alternative formulation.

In another alternative formulation, the aerosol cleaner uses either trichloroethylene or trans 1,2-dichloroethylene, preferably at a total concentration of about 7 percent to about 9 percent by weight in combination with a hydrofluoroether, preferably at about 21 percent

residual flammability. Thus, unlike known propellant-rich cleaner formulations, the preferred cleaner reduces and/or eliminates the risk associated with spraying the cleaner around energized electrical equipment and further reduces or eliminates the risk of re-energizing equipment prior to complete evaporation of the cleaner.

Such a cleaner also evaporates quickly after it is sprayed onto equipment. It has been found that the cleaner evaporates at least as fast as the earlier known CFC-113 aerosol cleaners. Even though the present cleaner evaporates quickly, it nevertheless exhibits insignificant icing. That is, there is little to no freezing of moisture out of the air onto the surface of the electrical components immediately following application of the cleaner. Such phenomena are typically exhibited with cleaners that rapidly evaporate. As will be understood by those skilled in the art, this icing effect is an undesirable characteristic of cleaners. To this end, although a considerable number of presently available commercial cleaners do, in fact, exhibit this effect to a relatively great extent, the preferred cleaner formulation does not.

With respect to cleaning of the electrical contact surfaces, in a typical application, these cleaners encounter lighter soils than do industrial degreasers. Typically these soils include dust, fingerprint oils and other light oils as opposed to adhesives, resins and the like. A most preferred cleaner should equal or better the cleaning performance of CFC-113 and should exhibit a cleaning characteristic of at least about 0.25 milligrams of soil per gram of cleaning product delivered.

In determining this cleaning characteristic, a group of rust-free 3 inch by 5 inch steel Q-panel samples were selected and prepared by first thoroughly cleaning the panels. Each of the group of panels was held using clean metal forceps to prevent later contamination and to assure complete preparation. The panels were cleaned by spraying each panel with LPS ZeroTri cleaner on their respective fronts and backs. This cleaner is available from LPS Laboratories of Tucker, Georgia.

The cleaned panels were placed on top of clean beakers in an oven at 105°C and allowed to dry thoroughly. The panels were removed from the oven and were placed upright on a clean surface to allow them to cool to room temperature.

The panels were then segregated for identification and were weighed on an analytical balance (capable of weighing to 0.1 mg) that was pre-tared with an appropriate

the solvents have been found to have low ozone depletion potentials (ODPs). As will be recognized by those skilled in the art, the lower the value of the ODP, the lower the adverse effect on the stratospheric ozone. To this end, it has been found that nPB has a low ODP, that is predicted to be about 0.002 to about 0.03 in a concentrated form. Most advantageously, the ODP of the cleaner is even lower when the nPB is in the final cleaner formulation.

In addition to the low ODP, it has been found that nPB has a relatively low atmospheric life. In fact, the atmospheric life of nPB is about 16 days. As such, it is believed that the use of nPB will have little to no adverse effect on stratospheric ozone.

Moreover, nPB has been observed to have good solvency characteristics and minimal to no flammability. With respect to flammability, it has been observed that nPB and in particular the present cleaner formulation, exhibits little to no residual flammability when subject to a test similar to the Cleveland Open Cup Flash Point method. In this test, which will be recognized by those skilled in the art, an open flame is passed in proximity to an open pool or puddle of the material until evaporation. It was found that there was no ignition of the cleaner formulation.

As noted, a preferred propellant for use in the cleaner is an HFC liquefied gas. Most preferably, the propellant is a tetrafluoroethane (HFC-134a) and is present in a concentration of equal to or greater than 50 percent by weight of the cleaner. Most preferably, the propellant is present in a concentration of 60 percent or greater by weight of the cleaner.

Unexpectedly, it is has been found the present propellant-rich cleaning formulation provides nearly all of the desirable characteristics for such an electrical contact cleaner. That is, the cleaner does not exhibit flame extension when tested by the Flame Projection Test as set forth in Aerosol Guide, issued by Chemical Specialties Manufacturing Association (CSMA, Washington, D.C.), Revised Flammability Tests Methods For Aerosol Products, pages 11-12, 5th Ed., 1966. The Flame Projection Test provides a flame projection, also called a flame extension value, where lower values are preferred and a value of zero is most preferred. This is considered non-flammable for purposes of labeling and shipping. Nor, as discussed above, does the preferred cleaner exhibit significant

contact cleaner that was sprayed onto the surface of the panel. These values were multiplied by 1000 to obtain the value in milligrams of film (soil simulation agent) removed per gram of contact cleaner used.

The present cleaner also exhibits a degree of plastic compatibility. As will be recognized by those skilled in the art, numerous plastics are used for a substrate or support in printed circuit boards. One popular substrate material is polycarbonate. The known solvent-rich cleaners typically attack these plastic materials. To this end, while these known cleaners may, in fact be acceptable for use on the metal, electrically conducting surfaces, they can have a devastating impact on the plastic circuit board substrate. While the preferred cleaner in accordance with the present invention exhibits some attack of polycarbonate and other plastics used for circuit board manufacture, an alternate form of the preferred cleaner does not cause rapid cracking of the polycarbonate substrate material as is exhibited by known solvent-rich aerosol cleaners. Rather, the degradation is limited to slight crazing of a stressed, thin sheet of the polycarbonate material.

Another drawback to known propellant-rich cleaners is that their respective wetting characteristics are unacceptable. That is, these propellant-rich cleaners have not been shown to adequately wet the substrates. Wetting has been observed to enhance dissolving contaminants which, in turn, facilitates removal of these contaminants. This would then suggest that a propellant-rich cleaner would in fact exhibit lesser cleaning characteristics than known solvent-rich cleaners. However, unexpectedly, propellant-rich cleaners in accordance with the present invention can provide good wetting characteristics so that the circuit board and electrical contact surfaces are acceptably wetted when the cleaner is applied.

In addition, the preferred contact cleaner has a relatively high dielectric breakdown voltage. Early contact cleaners, e.g., CFC-based cleaners, exhibited high dielectric breakdown voltages, on the order of about 30 KV. However, as presented above, these early contact cleaners were found to be detrimental to stratospheric ozone, i.e., high ODP values. Subsequent contact cleaners that exhibited more acceptable ODP values, however, exhibited lower breakdown voltages, in the range of about 8-20 KV. The preferred contact

support so that the panels did not rest on the pan of the balance. The weight of each of the cleaned panels was recorded.

The cleaned panels were next sprayed on one side (a shiny side) with a film producing agent (LPS 1 Greaseless Lubricant commercially available from LPS Laboratories of Tucker, Georgia) to emulate soil or contamination. The excess agent was allowed to run off of the panel. The coated panels were placed, film side up, on top of beakers in the oven at 105°C for two hours to dry.

The panels were then removed and placed upright on a clean surface to allow the panels to cool to room temperature. The panels were then each weighed on the analytical balance and the weights recorded. The weight of each panel was subtracted from the combined weight of the panel plus dried film to determine the weight of the dried film (i.e., soil simulation agent) deposited.

A number of sample contact cleaner aerosol cans were then selected and the flow rate for a five second period for each aerosol can was determined. Each aerosol can was then weighed on a standard balance capable of weighing to 0.01 gm. and the weight was recorded.

The panels were each held upright and sprayed, from a distance of about six inches, on the entire film coated side of the panel with the contact cleaner for five seconds to apply approximately the same amount of contact cleaner to each panel. The cleaned panels were then placed on top of the beakers in the oven at 105°C to allow the panels to dry thoroughly.

Each of the cans of contact cleaner was then reweighed and the weight recorded. The after use weight was subtracted from the original full weight to determine the amount of contact cleaner that was sprayed from each can.

The now cleaned panels were then removed from the oven and were allowed to cool to room temperature.

Each panel was then weighed and the weight recorded. The cleaned weight was subtracted from the combined weight of the panel plus dried film to determine the weight of soil simulation agent that was removed in the cleaning process.

The solvency power of the contact cleaner was determined by dividing the weight (in grams) of the soil simulation agent that was removed by cleaning by the weight of

The preferred soil in regard to which the cleaning characteristic is expressed is the 'LPS 1' greaseless lubricant referred to herein,. It is made by LPS Laboratories 4647 Hugh Howell Road, Tucker, GA 30085-5052, U.S.A. and its technical characteristics are:-

LPS 1 Greaseless Lubricant

Ingredients	CAS Numbers	% WW	OSHA PEL	ACGIH TLV	OTHER LIMITS
ALIPHATIC HYDROCARBON	64742-47-8	70-80	N.E.	N.E.	100 PEL **
ALIPHATIC PETROLEUM NAPTHA	64742-30-9	20-30	5mg/m3*	5mg/m3*	10mg/m3* STEL
$C0_2$ PROPELLANT (aerosol only)	124-38-9	2-3	10,000 ppm	5,000 ppm	30,000 ppm STEL

* Oil mist

** Recommended by Supplier

Boiling point (F°)	350°F	Specific gravity (H20 = 1):	.80
Vapor pressure (mmHg @ 100F)	2	Percent volatile by volume (%):	95
Vapor density (Air = 1)	4.7	Evaporation rate (n-Butyl Acetate – 1):	.07

Solubility in water: Nil

Appearance and odor: Clear thin liquid sweet odor

Flash point 175° SETA Flash

Flammable limits (of diluent): LEL 1% UEL 6%

cleaner has a dielectric breakdown voltage in a range of at least about 20-30 KV, while maintaining an acceptably low ODP.

The present contact cleaner also exhibits advantageous properties with respect to aerosol delivery systems. The cleaner functions well in a variety of packaging or application systems. In particular, the cleaner functions well in packaging or systems in which the container is inverted for application, that is, the container it is turned upside down for spraying and use. Other considerations for which the present contact cleaner shows advantageous properties include low toxicity and ready availability of raw materials.

Other formulations of the present propellant-rich cleaner are also contemplated to be within the scope of the present invention. One such alternate formulation includes a solvent blend of trichloroethylene (TCE) and isopropyl alcohol. In this alternate formulation, the TCE is preferably present is a concentration of about 20 percent by weight and the isopropyl alcohol is preferably present in a concentration of about 2 to about 4 percent by weight. The remaining 76 to 78 weight percent is again propellant, preferably tetrafluoroethane (HFC-134a). This alternate cleaner formulation has physical and chemical properties similar to that of the nPB solvent-based formulation and, depending on the solvent blend composition, a degree of plastic compatibility, low or no ODP and no or low flammability characteristics.

In still further alternate formulations, the aerosol cleaner can use either trichloroethylene or trans 1,2-dichloroethylene, preferably at a total concentration of about 7 percent to about 9 percent by weight, in combination with the above-noted hydrofluoroether, commercially available from 3M Company under the tradename HFE 7100, preferably in a concentration of about 21 percent by weight of the cleaner as solvent. In these formulations, the solvent can further include isopropyl alcohol, preferably in a concentration of about 2 percent to about 4 percent by weight of the cleaner. The remaining 66 to 70 percent by weight of the cleaner for these alternate formulations is preferably tetrafluoroethane. These alternate cleaner formulations have physical and chemical properties similar to that of the nPB solvent-based formulation, and depending on the solvent blend composition, a degree of plastic compatibility, low or no ODP and no or low flammability characteristics.

CLAIMS

1. A propellant-rich aerosol cleaner for use with electrical circuit boards and electrical connector components, comprising:

- a solvent having a low ozone depletion potential; and a propellant,

wherein the solvent is present in a concentration of up to about 50 percent by weight of the cleaner and the propellant is present in a concentration of from about 50 percent by weight of the cleaner, and wherein the cleaner exhibits a cleaning characteristic of at least about 0.25 milligrams of soil per gram of cleaner delivered and wherein the cleaner further exhibits low to no residual flammability.

2. The propellant-rich aerosol cleaner in accordance with claim 1 wherein the propellant is present in a concentration of about 60 percent to about 80 percent by weight of the cleaner and the solvent is present in a corresponding concentration of about 20 percent to about 40 percent by weight of the cleaner.

3. The propellant-rich aerosol cleaner in accordance with claim 2 wherein said concentrations are about 60 percent and about 40 percent.

4. The propellant-rich aerosol cleaner in accordance with claim 1, 2 or 3 wherein the solvent comprises propyl bromide or other brominated solvent.

5. The propellant-rich aerosol cleaner in accordance with claim 4, wherein the solvent further comprises n-propanol.

6 The propellant-rich aerosol cleaner in accordance with claim 5 wherein the solvent comprises n-propyl bromide in a concentration of about 37 or 37.5 percent by weight of the cleaner and n-propanol in a concentration of about 1 percent to about 5 percent by weight of the cleaner.

In view of S.125 and the Protocol to Art 69 EPC a reasonable variation in the numerical limits of composition given herein is within the scope of the invention, Figures may for example be read as encompassing variation of up to 3 in 100 either way, for example 50 as encompassing 48.5 to 51.5.

16. The propellant-rich aerosol cleaner in accordance with claim 1 wherein the solvent comprises a hydrofluoroether and one of trans 1,2-dichloroethylene and trichloroethylene.

17. The propellant-rich aerosol cleaner in accordance with claim 16 wherein the hydrofluoroether is present in a concentration of about 21 percent by weight of the cleaner and the one of trans 1,2-dichloroethylene and trichloroethylene is present in a concentration of about 7 percent to about 9 percent by weight of the cleaner.

18. The propellant-rich aerosol cleaner in accordance with claim 16 or 17 wherein the solvent further comprises isopropyl alcohol.

19. The propellant-rich aerosol cleaner in accordance with claim 18 wherein the isopropyl alcohol is in a concentration of about 2 percent to about 4 percent by weight of the cleaner.

20. The propellant-rich aerosol cleaner in accordance with any one of claims 16 to 19 wherein the propellant comprises tetrafluroroethane.

21. The propellant-rich aerosol cleaner in accordance with claim 20 wherein the tetrafluoroethane is in a concentration of about 66 percent to about 70 percent by weight of the cleaner.

22. A propellant-rich aerosol cleaner for use with electrical circuit boards and electrical connector components, comprising:

a solvent having a low ozone depletion potential, the solvent comprising n-propyl bromide; and

a propellant comprising tetrafluorethane,

wherein the n-propyl bromide is present in a concentration of up to about 50 percent by weight of the cleaner, and the tetrafluoroethane is present in a concentration of from about 50 percent by weight of the cleaner, and wherein the cleaner exhibits a cleaning characteristic

7. The propellant-rich aerosol cleaner in accordance with any one of claims 1 to 6 wherein the propellant comprises an HFC liquefied gas.

8. The propellant-rich aerosol cleaner in accordance with clam 7 wherein the HFC liquefied gas is tetrafluoroethane.

9. The propellant-rich aerosol cleaner in accordance with claim 8 wherein tetrafluroethane, is present in a concentration of about 60 percent by weight of the cleaner.

10. The propellant-rich aerosol cleaner in accordance with claim 1 wherein the solvent comprises trichoroethylene.

11. The propellant-rich aerosol cleaner in accordance with claim 9 wherein the trichoroethylene. is present in a concentration of about 20 percent by weight of the cleaner.

12. The propellant-rich aerosol cleaner in accordance with claim 10 or 11 wherein the solvent further comprises isopropyl alcohol.

13. The propellant-rich aerosol cleaner in accordance with claim 12 wherein the isopropyl alcohol in a concentration of about 2 percent to about 4 percent by weight of the cleaner.

14. The propellant-rich aerosol cleaner in accordance with any one of claims 10 to 13 wherein the propellant comprises tetrafluoroethane.

15. The propellant-rich aerosol cleaner in accordance with claim 14 wherein the tetrafluoroethane is in a concentration of about 76 to about 78 percent by weight of the cleaner.

at least about 0.25 milligrams of soil per gram of cleaner delivered and wherein the cleaner exhibits low to no residual flammability.

23. The propellant-rich aerosol cleaner in accordance with claim 22 wherein the solvent is present in a concentration of about 20 percent to about 40 percent by weight of the cleaner and the propellant is present in a concentration of about 60 percent to about 80 percent by weight of the cleaner.

24. The propellant-rich aerosol in accordance with claim 23 wherein said concentrations are about 40 percent and about 60 percent.

25. The propellant-rich aerosol cleaner in accordance with claim 22, 23 or 24 wherein the solvent further comprises n-propanol.

26. The solvent-rich aerosol cleaner in accordance with claim 25 wherein the n-propanol is in a concentration of about 1 percent to about 5 percent by weight of the cleaner.

Application No: GB 0101854.8
Claims searched: 1-26

Examiner: S.I. AHMAD
Date of search: 16 May 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): C4X (X11)

Int Cl (Ed.7): C09K-3/30

Other: DATA-BASE : EPODOC, WPI, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NO RELEVANT DOCUMENT	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.